
Space Weather Technical Forecast

Issued on Saturday, 01 July 2023 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Isolated R1/R2 Radio Blackouts likely. Chance of G1 Geomagnetic Storm intervals 01 Jul. Active Fluence expected 01-04 Jul.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity at GOES16 showing occasional low-level C-class flares, the largest of which was a C4.2 event at 30/1354 UTC from AR3354 in the northwest quadrant. This sunspot group is by far the largest and most magnetically complex on the Earth-facing side of the Sun, and currently shows as an Fhc/Beta-Gamma-Delta region. The group has elongated slightly through the period, with a small overall decrease in penumbral area in the intermediate portion of the group, but it retains a single, small Mt Wilson delta spot. The remaining sunspots, six numbered and two unnumbered are considerably smaller, weaker and magnetically simple.

No Earth directed CMEs have been visible in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, indicates a weak connection to coronal hole 18 in the southwest quadrant, as the phi angle has been positive (away from the Sun) throughout. The solar wind speed was initially at Elevated levels between 500-550km/s in general, but with a peak of 592 km/s at 30/1406 UTC, then very slowly declining to 480km/s (Slightly Elevated) by the end of the period. The solar wind density was mostly just above average, peaking at 14 ppcc at 30/1213 UTC, with brief intervals of average density thereafter. The IMF was weak throughout, 7 nT or below, while the Bz was weak, and mainly negative until early afternoon on 30 Jun and mainly positive thereafter. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at Background levels.

High energy electron flux (greater than 2MeV) started at Moderate levels but soon reached the High threshold (1000 pfu) from 30/1205 UTC, peaking at 2632pfu at 30/1515UTC. Since then Electron flux has varied on a diurnal cycle, maintaining mainly High levels, but with a period of Moderate flux from 01/0010-0800 UTC. The 24-hour integrated fluence has been on an increasing trend, reaching the Active threshold at 01/1200 UTC. A fluence of 9.41×10^7 was recorded at 01/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Mainly Low activity is expected, but likely increasing to Moderate levels at times with isolated M-class flares, and with a slight chance of X-class flares. This risk is almost entirely from AR3354 at first, but may be enhanced by new or returning regions through the forecast period.

Solar Wind / Geomagnetic Activity: A CME which left the northeast quadrant of the Sun on 27 Jun may glance Earth on day 1 (01 Jul), or perhaps early day 2 (02 Jul), however this is rather low confidence. A CME associated with a M3.8 flare on the 29 Jun may also affect Earth as a glancing blow on day 4 (04 Jul).

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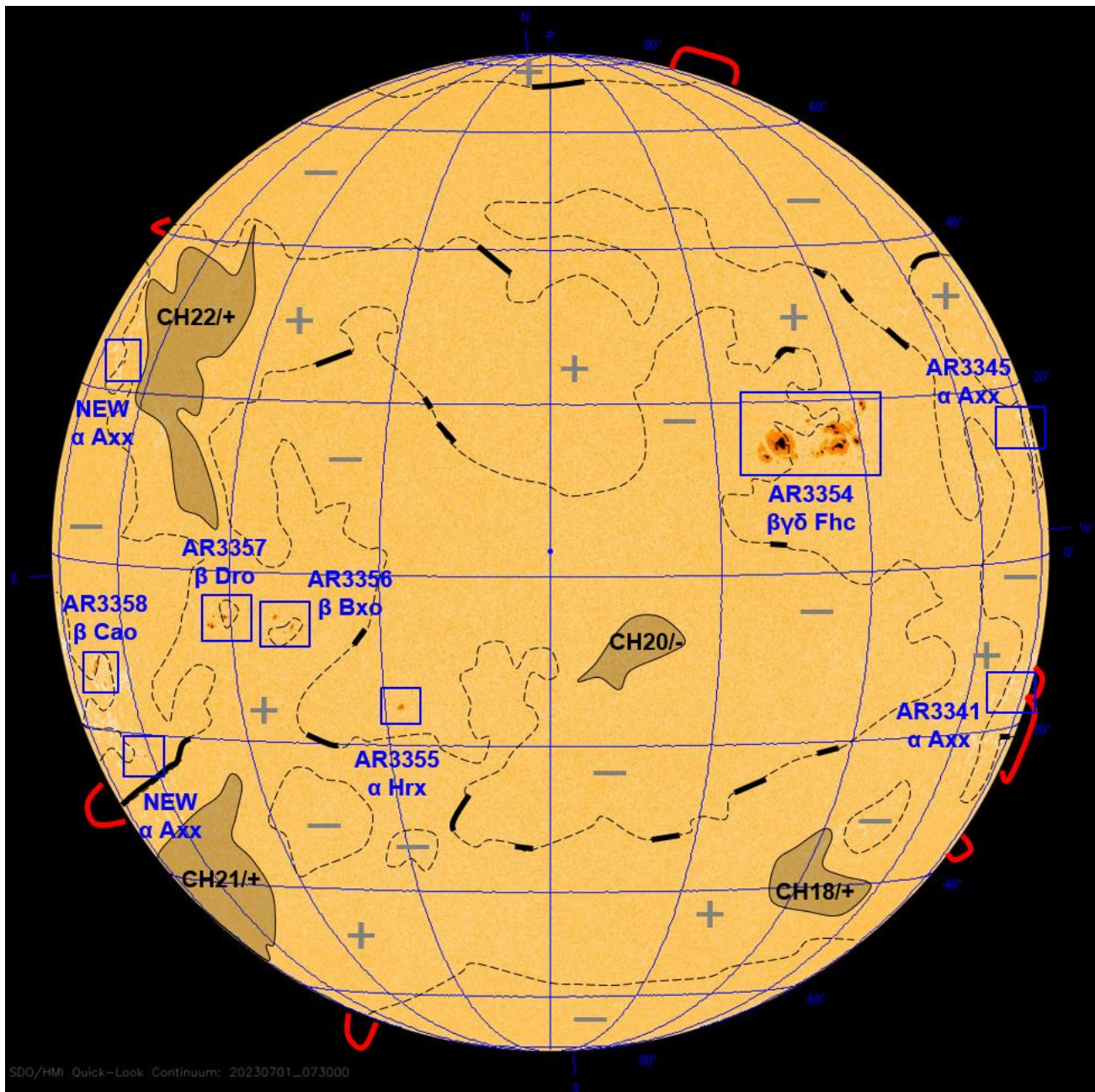
In the absence of any CME activity, the current slightly elevated fast wind from CH18/+ should slowly decline in the coming days. A connection to small CH20/- may occur on day 4 (4 Jul), however, any enhancements from this are expected to be weak, though may combine with the 29 Jun CME.

Predominantly Quiet (Kp 0-2) geomagnetic activity is expected through the period, with activity likely increasing to Unsettled (Kp 3) or Active (Kp 4) with any CME or high-speed stream arrivals. There is a slight chance of isolated G1/Minor Storm intervals on day 1 and day 4 for CME or combined CME and high-speed stream effects.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to remain at Background levels, but with a daily slight chance of reaching the S1/Minor Storm level, mainly due to AR3354.

High energy electron flux (greater than 2MeV) is expected to remain at diurnally Moderate to High levels (above 1000 pfu) in the coming days, unless the CMEs from 27 Jun or 29 Jun arrive at Earth, or connection to a weak high-speed stream occurs and geomagnetic activity subsequently increases. The corresponding fluence is now above the Active ($1e8$ integrated flux) threshold and likely to remain above until any significant geomagnetic activity from CME or high-speed stream influences occur. From day 3 (3rd July) the electron flux diurnal peaks should gradually reduce, with a falling probability of continuing to exceed the Active threshold.

Figure 1. Solar Analysis Valid 01/0730 UTC



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME which left the northeast quadrant of the Sun on 27 Jun may glance Earth on day 1 (01 Jul), but this is rather low confidence, with a potential arrival possible early on day 2 (2nd Jul). However, if the CME does arrive on day 2 this will indicate a very slow speed, and therefore the CME is likely to have less of a geomagnetic impact.

Another CME, associated with the M3.8 flare from AR3354 on the 29 Jun, may have an Earth-directed component. However, confidence for this CME is lower compared to the one from the 27 Jun, with the CME potentially arriving on day 4 (4 Jul).

Currently slightly elevated solar winds from the fast wind of CH18/+ should slowly decline in the coming days. A connection to small CH20/- may occur on day 4, however, any enhancements from this are expected to be weak, although may occur at a similar time to the arrival of the 29 Jun CME. Otherwise no new or recurrent coronal holes feature in the period.

It is therefore very possible, given the uncertainty of the CME arrivals, that the current fast wind from CH18/+ continues undisturbed until it naturally declines or is replaced by the onset of CH20/-. If this is the case then predominantly Quiet (Kp 0-2) geomagnetic activity is expected through the period, with activity likely increasing to Unsettled (Kp 3) or Active (Kp 4) with any CME or high-speed stream arrivals. There is a slight chance of isolated G1/Minor Storm intervals on day 1 and day 4 for CME or combined CME and high-speed stream effects.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	5	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0336	Partial	Filament eruption	NE quadrant	600km/s	01/1200 UTC +/-12 hours	Glancing impact, low confidence
29/1415	Partial	Flare	N centre disc	762km/s	04/0600 UTC	Extreme glance possible.

Radio Blackouts - X-Ray Flares:

Solar activity has been Low, with the largest flare of the period a C4.2 event at 30/1354 UTC from AR3354 in the northwest quadrant. There are nine sunspot regions on the visible disc, seven of which are numbered. Of these AR3354 remains by far the largest and most complex region, with one small Mt Wilson delta spot. It has gradually elongated over the past 24 hours, as well as displaying a slight reduction in penumbral area in the intermediate portion of the group. All other spots are small, simple and stable, with most of these located in the eastern hemisphere.

Mainly Low activity is expected, but likely increasing to Moderate levels at times with isolated M-class flares, and with a slight chance of X-class flares. This risk is almost entirely from AR3354 at first, but may be enhanced by new or returning regions through the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	40	40
Very Active	R3 to R5 X Class	No	10	10	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and is most likely to remain so throughout the period. However, there is a slight chance of S1 levels being reached due to the potential for AR3354 to produce significant flares, and given its favourable location in the western hemisphere to be magnetically connected with Earth.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

The current slightly enhanced solar wind from CH18/- should slowly ease in the coming days, but may be replaced by a weak enhancement from CH20/+ on day 4 (04 Jul). A continuation of flux and fluence levels near those seen at present (Moderate to diurnally High) is the most likely scenario during the forecast period, although with a gradual reduction likely later in the period. Therefore, the Met Office REFM model is considered to be offering good guidance.

However, the potential arrival of two rather low confidence CMEs, on day 1 (01 Jul) or day 4 (04 Jul) combined with the potential onset of CH20/+, may increase geomagnetic activity and lower the electron cloud at a much quicker rate than indicated.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	90	70	60
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 2: Latest GOES 16 Electron flux and MOSWOC REFM forecast

